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Media Coverage of Animal Handling and Welfare: Influence on Meat Demand

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Abstract

This article provides the first known examination of how animal welfare information provided by media sources impacts U.S. meat demand. Particular attention is focused on alternative techniques in deriving animal welfare media indices. Results suggest media attention to animal welfare has a small, but statistically significant impact on meat demand. Alternative derivations of media indices alter conclusions regarding spillover effects across meats, net impacts on total meat demand, and longevity of impacts. Articles referencing consumer groups impact demand more than those noting U.S. government or livestock industry entities.

Key words: animal welfare, consumer demand, information indices, meat quality, media coverage, Rotterdam model, source of information

Consumers are increasingly interested in the production practices used in modern food production. A particular issue rapidly increasing in importance to US consumers is if animals were handled in an "animal friendly manner." Residents have signaled concern for animal well-being with ballot initiatives having been passed by residents of Florida, Arizona, and California that ban the use of gestation crates in swine production in their state (Videras, 2006). Moreover, food retailers (i.e., McDonald's and Burger King) are sourcing an expanding share of their food from crate free sources; partly in response to corporate activism exerted by consumer activist groups concerned with animal handling (Hudson and Lusk, 2004). However, there remains an unanswered question, what is the impact of animal welfare on US consumer demand for meat?

A number of recent studies have assessed consumer willingness to pay (WTP) for animal welfare attributes in meat products (Carlsson, Frykblom, and Lagerkvist, 2007a-b; Lagerkvist, Carlsson, and Viske, 2006; Lijenstolpe, 2008; Lusk, Norwood, and Pruitt, 2006; Tonsor, Olynk, and Wolf, forthcoming). These studies have exclusively used consumer-level methods, primarily with European consumer samples. Moreover, ballot initiatives that have passed have been lead by consumer groups notably concerned with animal welfare issues; yet the impacts on consumption patterns is uncertain. In short, it remains to be seen to what extent animal welfare concerns impact aggregate demand for meat products, an issue critically different from resident support for ballot initiatives (Tonsor, Wolf, and Olynk, forthcoming).

Furthermore, there is a growing literature evaluating the impact of media coverage on consumer choices (Piggott and Marsh, 2004; Kalaitzandonakes, Marks, and Vickner, 2004; Lusk et al. 2004). Given the rapid increase in animal welfare concerns

and associated public press on the issue, a prudent question to ask is how increasing media coverage of animal handling and welfare impacts meat demand. Accordingly, this paper seeks to address unanswered, but valuable questions including: 1) *Has media coverage led to a net shift out of meat (beef, pork, and poultry), a reallocation across meats, or had no impact on meat demand?;* 2) *Does media coverage have spillover effects (i.e., how does attention to the welfare of hogs impact beef demand) across meats?*; 3) *How long does media coverage impact meat demand?*; and 4) *How sensitive are conclusions to how media indices are created?*

The manuscript proceeds with a short overview of related literature followed by a discussion of the methods and data utilized. The article then concludes with results discussion and summary comments and implications.

Prior Research

There exist a significant literature analyzing meat demand shifters including effects of health and related diet information (Adhikari et al., 2006; Kinnucan et al., 1997; Miljkovic and Mostad, 2005; Rickertsen, Kristofersson, and Lothe, 2003; Brown and Schrader, 1990; Chang and Kinnucan, 1991; Capps, Jr. and Schmitz, 1991); food safety and product recall news (Piggott and Marsh, 2004; Marsh, Schroeder, and Mintert, 2004; Burton and Young, 1996); generic advertising (Brester and Schroeder, 1995; Kinnucan et al., 1997; Rickertsen, 1998; Piggott et al., 1996; Park and Capps, Jr., 2002); pre-committed demand (Piggott and Marsh, 2004; Tonsor and Marsh, 2007); and structural changes (Eales and Unnevehr, 1988; Rickertsen, 1996; Moschini and Meilke, 1989; Davis, 1997). This vast literature also varies in the data sets and empirical methodologies employed. As strongly suggested by Just (2001),

several of these studies (e.g., Kinnucan et al., 1997; Rickertsen, Kristofersson, and Lothe, 2003; Brown and Schrader, 1990; Chang and Kinnucan, 1991; Piggott and Marsh, 2004) incorporate indices of media attention (e.g., cholesterol and food safety indices) as potential demand shifters in their analyses. This seems appropriate as the majority of U.S. consumers receive substantial information about food products and technology through the popular press and television (Kalaitzandonakes, Marks, and Vickner, 2004; Hoban and Kendall, 1993). In the context of animal welfare information very little information is available on food product labels, a fact which likely enhances the impact of the media on consumer demand. However, no study has addressed the question of how sensitive conclusions are to alternative approaches to media index creation or more narrowly the impact of media attention to animal welfare issues.

A number of recent studies have assessed consumer willingness to pay (WTP) for animal welfare attributes in meat products (Carlsson, Frykblom, and Lagerkvist, 2007a-b; Lagerkvist, Carlsson, and Viske, 2006; Lijenstolpe, 2008; Lusk, Norwood, and Pruitt, 2006; Tonsor, Olynk, and Wolf, forthcoming). Each of these studies assess demand for individual product attributes using consumer-level data and modeling techniques, rather than national, aggregate demand at the commodity level.

In short, while a wealth of work has evaluated consumer demand, perceptions, and preferences regarding a range of food product attributes, to-date we are unaware of any work evaluating the impact of animal welfare information on aggregate meat demand by consumers. Moreover, methodological questions remain regarding the sensitivity of inferences regarding consumer demand to alternative approaches to creating media indices. We aim to begin filling these notable gaps with this manuscript.

Research Methods

As in Basmann (1956), Swartz and Strand (1981), Foster and Just (1989) Mojduska and Caswell (2000), and Piggott and Marsh (2004) we assume that publically available information impacts consumer perceptions of product quality, which in turn influences exercised consumption decisions. In our analysis of U.S. meat demand, quality is presumed to potentially be influenced by media information regarding animal handling and welfare concerns.

Model Specification

To assess the meat demand impacts of this media information, we estimate an absolute-price version of the Rotterdam model, comprised of four equations accounting for beef, pork, poultry, and non-meat food. The Rotterdam model has been widely used in meat demand analyses (Kinnucan et al., 1997; Marsh, Schroeder, and Mintert, 2004) and is of particular interest here because it easily accommodates inclusion of multiple covariates that may be highly correlated in levels, but not in first differences. The estimated model's share equations are given by:

$$w_i \Delta \ln x_i = a_{io} + \sum_{j=1}^{3} d_{ij} D_j + \sum_{j=1}^{n} c_{ij} \Delta \ln p_j + \beta_i \Delta \ln \bar{q} + \sum_{k=1}^{K} \sum_{l=0}^{L} \delta_{ikl} \Delta \ln M_{kl} + \nu_i \,, \qquad (1)$$

where w_i is budget share of the ith good (i=1,…,4), Δ is the standard across-period first-difference operator, x_i is per capita consumption of good i, D_j is a quarterly dummy variable included to capture seasonality, p_j is the price of the jth good, $\Delta \ln \bar{q}$ is Divisia volume index, M_{kl} represents the kth exogenous shifter (i.e., media coverage index) with

lag length of l, v_i is a random error term, and $a_{io}; d_{ij}; c_{ij}; \beta_i; \delta_{ikl}$ are parameters to be estimated. The a_{io} term is a time trend variable included for structural changes not captured by the M_{kl} exogenous shifters. The inclusion of non-meat food in the demand system allows us to examine not only within-meat impacts of media coverage, but also implications regarding shifts out of total meat consumption. This contribution would not be possible if a "meat separable" assumption was applied (e.g., Piggott and Marsh, 2004). That is, adding-up requirements would constrain media attention to animal welfare to have a net-zero impact on meat demand, an undesirable trait that is avoided by including non-meat food in the estimated demand system (Marsh, Schroeder, and Mintert, 2004). Stated differently, including non-meat food in the estimated demand system allows consumers to alter the percentage of spending on all food, where a "meat separable" assumption would force total meat demand to remain constant.

One share equation from our demand model is deleted from the system prior to estimation to avoid singularity in the estimated variance-covariance matrix of the error terms. The parameters of this omitted equation are recovered using the adding-up restrictions. In addition to the adding-up restrictions, symmetry and homogeneity restrictions are imposed as maintained assumptions to ensure the demand model is consistent with economic theory. Adding-up conditions are imposed by requiring:

$$\sum_{i=1}^{N} c_{ij} = 0, \sum_{i=1}^{N} \beta_i = 1, \sum_{i=1}^{N} \delta_{ikl} = 0, \text{ and } \sum_{i=1}^{N} d_{ij} = 0 \quad (2).$$

Homogeneity and symmetry are imposed by:

$$\sum_{j=1}^{N} c_{ij} = 0 \text{ and } c_{ij} = c_{ji} \quad (3).$$

Combined, equations (1) – (3) lead to compensated price, income, and shifter elasticities given by (Marsh, Schroeder, and Mintert, 2004):

$$\varepsilon_{ij} = \frac{c_{ij}}{w_i}, \eta_i = \frac{\beta_i}{w_i}, \text{ and } \kappa_{ikl} = \frac{\sum_{l=0}^{L} \delta_{ikl}}{w_i}, \text{ respectively} \quad (4).$$

Upon estimation of the empirical model, media impact elasticities can be identified and tests conducted of the unanswered questions noted in the introduction above.

Estimation Methods

Given noted concerns with endogeneity of quantities and/or prices in meat demand models (e.g., Eales and Unnevehr, 1993; Stockton, Capps, and Bessler, 2008), we followed Thurman (1987) and conducted Hausman specification tests. In particular we estimated our Rotterdam models in two different ways. First, the right-hand-side variables are assumed to be pre-determined and our model is estimated using iterative Seemingly Unrelated Regression (ITSUR) techniques. Second, the right-hand-side variables are assumed to be endogenous and iterative Three Stage Least Squares (IT3SLS) methods are used for estimation. Instruments employed in the IT3SLS approach follow those used by Eales and Unnevehr (1993), Capps et al. (1994), and Kinnucan et al. (1997) and include lagged prices and quantities, total per capita expenditure, a price index for energy, the price of corn received by producers, weekly wages of meat packing plant workers, 90- day Treasury bill yields, U.S. population, and meat processed from animal carcasses. The null hypothesis of price exogeneity was rejected in all evaluations. As such, all represented results reflect use of IT3SLS estimation method.

Our empirical analysis was conducted using an iterative approach of multiple model estimations with a range of likelihood ratio tests employed. We used adjusted likelihood ratio tests to compare alternative model specifications (Bewley, 1986). While traditional likelihood ratio tests rely on asymptotic assumptions, the adjusted likelihood ratio test statistics do not. Models were estimated with lag lengths of 0 to 4 quarters for each exogenous shifter (M_{kl}).

Following Piggott and Marsh (2004), Holt and Goodwin (1997), and Tonsor and Marsh (2007), three different Berndt and Savin (1975) autocorrelation corrections were evaluated. These three corrections consisted of: (1) a null correction matrix restricting all elements to zero (i.e., no autocorrelation correction; $\rho_{ij} = 0 \; \forall_{ij}$); (2) a diagonal correction matrix with all off-diagonal elements restricted to zero and all diagonal elements to be identical ($\rho_{ij} = 0 \; \forall_{i \neq j}$ and $\rho \neq 0 \; \forall_{i=j}$); and (3) a complete correction matrix allowing all elements to differ individually from zero ($\rho_{ij} \neq 0 \; \forall_{ij}$). In our application, the null and diagonal correction specifications are rejected in favor of the complete correction matrix for all evaluated models.

Media Indices

Following previous research (Piggott and Marsh, 2004) Lexis-Nexis databases were used to construct indices capturing public information. In particular, indices reflecting public information on animal welfare were derived to be incorporated in equation (1) as variables denoted by M_{kl}.

The core keywords used in our searches of the Lexis Nexis Academic database were: *"(animal welfare) or (animal friendly) or (animal care) or (animal handling) or*

(animal transportation) or humane or (humanely raised) or cage or crate or stall." Use of these keywords, without additional constraints, led to the index named *GENERAL* in Table 1. This approach is similar to that of Kinnucan et al. (1991) as it is not species-specific.

Our second approach follows Piggott and Marsh (2004) to generate species-specific media indices. In particular, we limited the *GENERAL* search results by appending "AND (beef or cattle)," "AND (pork or swine or hogs)," and "AND (poultry or turkey or chicken)," respectively. These three species specific searches provide the indices referred to as *BEEF_NoSource*, *PORK_NoSource*, and *POULTRY_NoSource AW Index* throughout the article.

Neither of these first two approaches attempt to control for the source of evaluated media articles. This may be important as multiple consumer-level studies have found trust in alternative information sources to impact risk perceptions and meat demand (i.e., Tonsor, Schroeder, and Pennings, forthcoming). McCluskey and Swinnen (2004) also note information provided by the media is rarely neutral as information distributing organizations usually have internal incentives to select and promote certain information. Moreover, Mazzocchi et al. (2008) note the source of a media article may be important to assess and state that "more sophisticated constructs of media count variables that take account of the source of the story would be sensible (pp. 21)." Even if the source of an article can not be clearly identified using automated keyword search techniques, identifying if government, food industry, and/or consumer group entities are mentioned in an article may be important. Accordingly our third approach repeats the *GENERAL*

search with added constraints regarding mention of specific entities to attempt and bridge this gap in the current application of media indices in demand analyses.

The *GENERAL_Government* index (Table 1) was created by adding the following constraint to the *GENERAL* search: "AND ((United States Department of Agriculture) or USDA or (Food Safety and Inspection Service) or FSIS or (Animal and Plant Health Inspection Service) or APHIS or (Grain Inspection, Packers and Stockyards Administration) or GIPSA or (Food and Drug Administration) or FDA or (Federal Government) or (State Government) or (Environmental Protection Agency) or EPA or (Agricultural Marketing Service) or AMS or (Animal Welfare Information Center) or AWIC)."

Similarly, the *GENERAL_Industry* index was generated by adding the constraint of: "AND ((National Pork Producers Council) or NPPC or (National Pork Board) or NPB or (US Poultry and Egg Association) or USPEA or (United Egg Producers) or UEP or (National Cattlemen's Beef Association) or NCBA or (Ranchers-Cattleman Action Legal Fund) or R-CALF)."

Finally, the *GENERAL_Consumer* index was developed by using the 2008 issue of *Animal People* magazine to identify the top 20 consumer groups, ranked in terms of their annual funds raised. This led us to constrain our *GENERAL* search by appending the following constraint: "*AND ((Nature Conservancy) or (Wildlife Conservation Society) or (World Wildlife Fund) or WWF or (Humane Society of the US) or HSUS or (Heifer International) or (Environmental Defense Fund) or (International Fund for Animal Welfare) or (National Wildlife Federation) or (Sierra Club) or (National Audubon Society) or (Natural Resources Defense Council) or (American SPCA) or SPCA*

or (Massachusetts SPCA) or (Wilderness Society) or (Best Friends Animal Sanctuary) or (North Shore Animal League) or (People for the Ethical Treatment of Animals) or PETA or (World Society for the Protection of Animals) or (Defenders of Wildlife) or (EarthJustice)).”

Our fourth and final approach to generating media indices attempts to control for both species and entity effects. In particular, we merge our second (species-specific) and third (entity delineated) approaches to generate *BEEF_Government, PORK_Govermnet, POULTRY_Government, BEEF_Industry, PORK_Industry*, *POULTRY_Industry, BEEF_Consumer, PORK_Consumer*, and *POULTRY_Consumer* indices (table 1).

Summary Statistics

The demand model is estimated with quarterly data comprised of beef, pork, poultry, and non-meat food from 1982 through 2008. Summary statistics are presented in table 1. The beef, pork, and poultry quantity variables correspond to quarterly per capita disappearance, in retail weight (pounds/capita). Per capita consumption averaged 21.4, 17.3, and 12.7 lbs/capita/quarter, respectively for poultry, beef, and pork (table 1). Beef, pork, and poultry prices are quarterly average retail prices ($/pound). Chicken and turkey were aggregated to form one poultry variable (Marsh, Schroeder, and Mintert, 2004). Accordingly, poultry price reflects total expenditure on chicken and turkey divided by per capita poultry consumption. All beef, pork, and poultry quantity and price series were obtained from the United States Department of Agriculture’s Economic Research Service (USDA-ERS).

Table 1 also provides summary statistics of the multiple media information indices which were created. By design, the "GENERAL" searches encompass a larger number of media articles than those more constrained by species and/or entity restrictions. Figures 1-5 also illustrate the information indices created using these different approaches over the sample period of 1982(1)-2008(4). Overall, the indices focused on poultry reveal higher levels of media attention. Moreover, articles discussing livestock entities are notably less prevalent than those with reference to government or consumer groups.

Each created index has increased over time, especially over most recent years. Not surprisingly, the *BEEF_NoSource* (Figure 1), *BEEF_Consumer* (Figure 4), and *BEEF_Government* (Figure 5) indices clearly have sharp increases early in 2008 when the highly publicized Westland/Hallmark event occurred in Chino, CA. The pattern of these multiple indices, which reflect alternative ways of deriving proxy variables of media attention to animal welfare, varies raising intriguing questions regarding implications on meat demand inferences. This paper proceeds with discussion of our Rotterdam model results.

Results

Tables 2-7 present the estimated compensated elasticities from alternative Rotterdam models varying in use of different animal welfare media information elasticities. The models fit the data reasonably well as indicated by R^2 values ranging from 67% to 85% depending on the share in question and the particular media indices approach applied. In general, the model results follow existing literature in terms of seasonality effects and

conform to curvature expectations as all estimated price coefficient matrices are negative semidefinite.[1] Moreover, the price and expenditure elasticities are rather robust to the selection of media information indices. In particular the estimated beef, pork, and poultry own-price elasticities range from -0.44 to -0.50, -0.76 to -0.84, and -.07 to -.17, respectively and all differ significantly from -1.0 (0.10 level). Our systematic conclusion of pork being the most elastic and poultry the most inelastic of the meats is consistent with Brester and Schroeder (1995) and Tonsor and Marsh (2007).

Given our principal interest is the impact of increasing media attention to animal welfare issues on meat demand it is useful to summarize corresponding inferences that stem from alternative approaches to capturing this media attention. Our first approach (*GENERAL*) is the least constrained (e.g., highest volume of "hit" articles) of four considered approaches and closely follows similar applications focused on health impacts on meat demand (i.e., Kinnucan et al., 1997). Table 2 shows this approach suggests media attention to animal welfare issues increased pork demand (0.08 elasticity) in the short run and reduced both beef (-0.06) and poultry (-0.13) demand in the long-run. Moreover, this approach suggests a net loss of meat demand for non-meat food in the long-run from increasing media attention. Overall these conclusions seem plausible as long-run, net-losses to meat demand seem reasonable and pork demand benefits are limited to being contemporaneous only.

To evaluate possible spillover effects of information regarding one species on a competing meat category, we also created species-specific indices (*BEEF_NoSource*, *PORK_NoSource*, and *POULTRY_NoSource*) following the approach of Piggott and Marsh (2004). Results shown in table 3 reflect an inability to reject the null hypothesis

[1] While not presented for brevity, the coefficients of each estimated model are available upon request.

(per likelihood ratio tests) of these cross-species spillover effects being jointly zero. The magnitude of estimated elasticities is also notably lower than those resulting from the *GENERAL* index approach. In particular, media articles focused on the beef industry appear to enhance beef demand (0.01 and 0.03 elasticities in short- and long-run, respectively) while articles focusing on the poultry industry initially boost demand (0.02 elasticity) and eventually reduce demand over two quarters (-0.04).

As previously discussed, the results presented in tables 2 and 3 fail to consider any sensitivity that may be related to the source of, or the entities mentioned or cited within media articles. Table 4 presents results of a model estimated with media attention being captured by the *GENERAL_Industry* and *GENERAL_Consumer* variables.[2] Using this approach suggests beef and pork demand is unaffected by media attention to animal welfare. Conversely, poultry demand is reduced both in the short-term (-0.02 elasticity) and long-term (-0.05 elasticity) as media attention expands.

Tables 5-7 present results of our final approach to capture media attention. In particular, tables 5-7 summarize results of models using species-specific searches that are also narrowed to industry, consumer group, and government entities, respectively. Using species-specific, industry entity mentioning articles (table 5) suggests pork demand is reduced both in the short- (-0.007 elasticity) and long-run (-0.007 elasticity) while poultry demand is expanded from additional media attention (0.008 and 0.013 short- and long-run elasticities, respectively). Using this approach we also fail to reject the hypothesis of cross-species, spillover effects being jointly zero.

[2] The *GENERAL_Government* index was not included as it is highly correlated (0.66 in first-differences) with the *GENERAL_Consumer* index.

Table 6 presents the results of using species-specific, consumer group mentioning articles. This is the only approach in which we reject the hypothesis of jointly zero cross-species, spillover effects (7 of 9 cross-effects are individually significant) as well as the only approach in which media attention impacts are fully experienced contemporaneously within the quarter of article releases. Using this approach we find articles mentioning both the beef industry and consumer groups to expand beef demand (0.01 elasticity). Conversely articles discussing the poultry industry and consumer groups reduce both beef (-0.02 elasticity) and poultry (-0.02 elasticity) demand. Interestingly, beef and pork demand are found to experience positive spillovers when the competing meat industry is discussed by the media.

Table 7 presents elasticity estimates of using a model characterized by species-specific, government entity mentioning media article indices. Using this approach we conclude beef demand is enhanced, both in the short- (0.01 elasticity) and long-run (0.01 elasticity), and poultry demand is enhanced in the short-run (0.02 elasticity) when articles are released discussing these two industries and government entities.

Conclusions and Implications

This article provides the first known assessment of U.S. meat demand impacts from increasing media attention to animal welfare issues with a robust assessment of how alternative approaches to proxying this media attention impact corresponding demand inferences. Media attention to animal welfare has statistically significant, but generally small effects in magnitude as compared with price and expenditure effects.

While media attention elasticity estimates are small, it is important to not mistake this for evidence of demand being insensitive to animal welfare media attention. The number of media articles focused on animal welfare has trended steadily upward over the time period investigated. Further a doubling of media articles regarding animal welfare has occurred in the past within a given quarter. Moreover, given the sheer volume and value of meat produced and consumed in the United States, adjustments in aggregate consumer demand of 1 or 2% are certainly economically important.

Although media attention elasticities were routinely statistically significant, the inferences one draws regarding demand impacts are rather sensitive to how media indices are created. In particular, alternative derivations of media indices alter conclusions regarding spillover effects across meats, net impacts on total meat demand, and longevity of impacts. For instance, in most cases media attention to animal welfare is found to have impacts for up to 6 months. However, when only articles mentioning consumer groups are included in indices, demand impacts are found to last only 3 months. Media attention is not generally found to have spillover effects across meats. However, when indices specific to consumer groups are used, beef demand is found to be impacted by media attention in the pork industry and, similarly, pork demand is impacted by media attention to the beef industry.

It has been argued that applied economic analysis should incorporate media coverage information (Just, 2001), however no known work has assessed alternative ways to do this. This article provides the first known assessment and highlights a number of important issues. Findings regarding media attention impacts are likely sensitive to how proxy variables are created to capture this media attention. This finding is hardly

surprising and is consistent with McCluskey and Swinnen (2004) who suggest information provision is likely not neutral and hence measured impacts on food demand will not be information source neutral.

Our in-depth assessments of alternative approaches to proxying media attention reveal sensitivity to how media indices are created. The differences in inferences drawn from various methods for media index creation highlight the need for alternative indices to be used in analyses incorporating media indices or, at least, for awareness in such studies regarding the possible sensitivity of results to index creation methods. General conclusions drawn or results used for policy creation should be particularly mindful of the sensitivity to media index creation methods on the results and implications highlighted in this analysis.

This paper highlights several arenas worthy of future research. For instance, a comparable assessment of media index creation sensitivity could be conducted on use of controversial technologies (e.g., rbST in milk; growth hormones in beef) employed in food production that have seen notable media attention and debate. Moreover, additional research more narrowly assessing the impacts of information source on subsequent food demand is warranted.

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Table 1. Summary Statistics of Quarterly Data used to Estimate Demand Models 1982-2008.

Variable	Average	Std. Dev.	Minimum	Maximum
Beef Consumption (lbs/capita)	17.3	1.3	15.0	20.8
Pork Consumption (lbs/capita)	12.7	0.7	11.4	14.3
Poultry Consumption (lbs/capita)	21.4	3.7	13.7	27.0
Retail Beef Price ($/lb)[a]	2.0	0.2	1.7	2.5
Retail Pork Price ($/lb) [a]	1.6	0.1	1.4	2.0
Retail Poultry Price ($/lb) [a]	0.7	0.1	0.5	0.9
General Search[b]				
GENERAL	8,804.5	7,162.3	435.0	24,182.0
Species-Specific Searches[b]				
BEEF_NoSource	255.8	237.8	13.0	1,485.0
PORK_NoSource	149.4	134.7	5.0	634.0
POULTRY_NoSource	478.6	410.8	29.0	1,405.0
Source/Entity-Delineated Searches[b]				
GENERAL_Government	1,021.6	816.2	63.0	3,168.0
PORK_ Government	31.8	33.3	0.0	122.0
POULTRY_ Government	66.3	65.1	3.0	308.0
BEEF_ Government	56.2	92.7	0.0	900.0
GENERAL_Industry	7.2	10.9	0.0	48.0
PORK_ Industry	1.6	2.8	0.0	16.0
POULTRY_ Industry	2.7	5.8	0.0	34.0
BEEF_ Industry	2.1	4.3	0.0	22.0
GENERAL_Consumer	585.1	576.3	14.0	2,383.0
PORK_ Consumer	14.9	19.1	0.0	100.0
POULTRY_ Consumer	51.4	58.4	1.0	264.0
BEEF_ Consumer	31.6	67.5	0.0	680.0

[a] Inflation-adjusted dollars (deflated by CPI, 1982-1984=100)
[b] Details on construction of each media information index are provided on pages 10-12.

Table 2. Estimated Compensated Elasticities - General Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.5041**,[a]	0.0911*	0.0023	0.0063**
Pork Price	0.0504*	-0.7992**,[a]	-0.1250**	0.0064**
Poultry Price	0.0013	-0.1250**	-0.0731*,[a]	0.0015**
Other Food Price	0.4524**	0.8331**	0.1959**	-0.0143**,[a]
Expenditure	0.2830[b]	0.1052[b]	0.0410[b]	1.0219**,[b]
Short Run AW Elasticities:				
General	-0.0184	0.0790**	-0.0118	-0.0003
Long Run AW Elasticities:				
General	-0.0633**	0.0072	-0.1313**	0.0015**

Note: Log-likelihood value is 2,249.55; R-square statistics of the beef, pork, and poultry share equations are 72.0%, 83.9%, and 78.5%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures. *Long-run AW* elasticities capture contemporaneous and one-quarter lagged effects.

*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

Table 3. Estimated Compensated Elasticities - Species-Specific Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.4790**,[a]	0.0480	-0.0294	0.0065**
Pork Price	0.0266	-0.8059**,[a]	-0.1549**	0.0067**
Poultry Price	-0.0110	-0.1051**	-0.1196*,[a]	0.0016**
Other Food Price	0.4635**	0.8629**	0.3038**	-0.0147**,[a]
Expenditure	0.3021 [b]	0.1270 [b]	0.1519 [b]	1.0209 [b]
Short Run AW Elasticities:				
BEEF_NoSource	0.0113*			-0.0002*
PORK_NoSource		-0.0027		0.0000
POULTRY_NoSource			0.0223*	-0.0001*
Long Run AW Elasticities:				
BEEF_NoSource	0.0346**			-0.0005**
PORK_NoSource		0.0152*		-0.0001*
POULTRY_NoSource			-0.0384*	0.0002*

Note: Log-likelihood value is 2,250.69; R-square statistics of the beef, pork, and poultry share equations are 71.8%, 83.9%, and 79.8%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures. *Long-run AW* elasticities capture contemporaneous and one-quarter lagged effects.

*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

Table 4. Estimated Compensated Elasticities - Source Delineated Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.4798**,[a]	0.0620	0.0120	0.0062**
Pork Price	0.0343	-0.8431**,[a]	-0.2195**	0.0072**
Poultry Price	0.0045	-0.1489**	-0.1549**,[a]	0.0019**
Other Food Price	0.4410**	0.9301**	0.3624**	-0.0152**,[a]
Expenditure	0.2581 [b]	-0.0027 [b]	0.1335 [b]	1.0226**,[b]
Short Run AW Elasticities:				
General_Industry	0.0042	-0.0053	-0.0039	0.0000
General_Consumer	-0.0037	0.0017	-0.0176*	0.0001
Long Run AW Elasticities:				
General_Industry	0.0013	-0.0049	0.0008	0.0000
General_Consumer	0.0007	-0.0102	-0.0470**	0.0003

Note: Log-likelihood value is 2,239.95; R-square statistics of the beef, pork, and poultry share equations are 71.1%, 83.2%, and 78.0%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures. *Long-run AW* elasticities capture contemporaneous and one-quarter lagged effects.

*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

Table 5. Estimated Compensated Elasticities - Industry Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.4812**,[a]	0.0730	0.0510	0.0059**
Pork Price	0.0404	-0.7726**,[a]	-0.1450**	0.0062**
Poultry Price	0.0191	-0.0984**	-0.1117[a]	0.0011*
Other Food Price	0.4217**	0.7980**	0.2058	-0.0131**,[a]
Expenditure	0.3133**,[b]	0.0440[b]	0.1772[b]	1.0213**,[b]
Short Run AW Elasticities:				
BEEF_Industry	-0.0003			0.0000
PORK_Industry		-0.0066*		0.0001**
POULTRY_Industry			0.0078*	-0.00004*
Long Run AW Elasticities:				
BEEF_Industry	-0.0006			0.0000
PORK_Industry		-0.0071**		0.0001*
POULTRY_Industry			0.0131**	-0.0001**

Note: Log-likelihood value is 2,249.14; R-square statistics of the beef, pork, and poultry share equations are 72.3%, 84.7%, and 78.4%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures. *Long-run AW* elasticities capture contemporaneous and one-quarter lagged effects.

*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

Table 6. Estimated Compensated Elasticities - Consumer Group Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.4415**,[a]	0.0995*	0.0927	0.0049**
Pork Price	0.0550*	-0.8418**,[a]	-0.1215**	0.0064**
Poultry Price	0.0348	-0.0824**	-0.1745**,[a]	0.0011*
Other Food Price	0.3517**	0.8247**	0.2033**	-0.0123**,[a]
Expenditure	0.2947[b]	0.1289[b]	0.1860[b]	1.0208**,[b]
Short Run AW Elasticities:				
BEEF_Consumer	0.0103**	0.0084**	-0.0001	-0.0002**
PORK_Consumer	0.0205**	-0.0106**	-0.0078**	-0.0002**
POULTRY_Consumer	-0.0243**	-0.0010	-0.0157*	0.0004**

Note: Log-likelihood value is 2,224.94; R-square statistics of the beef, pork, and poultry share equations are 66.6%, 83.0%, and 77.0%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures.

*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

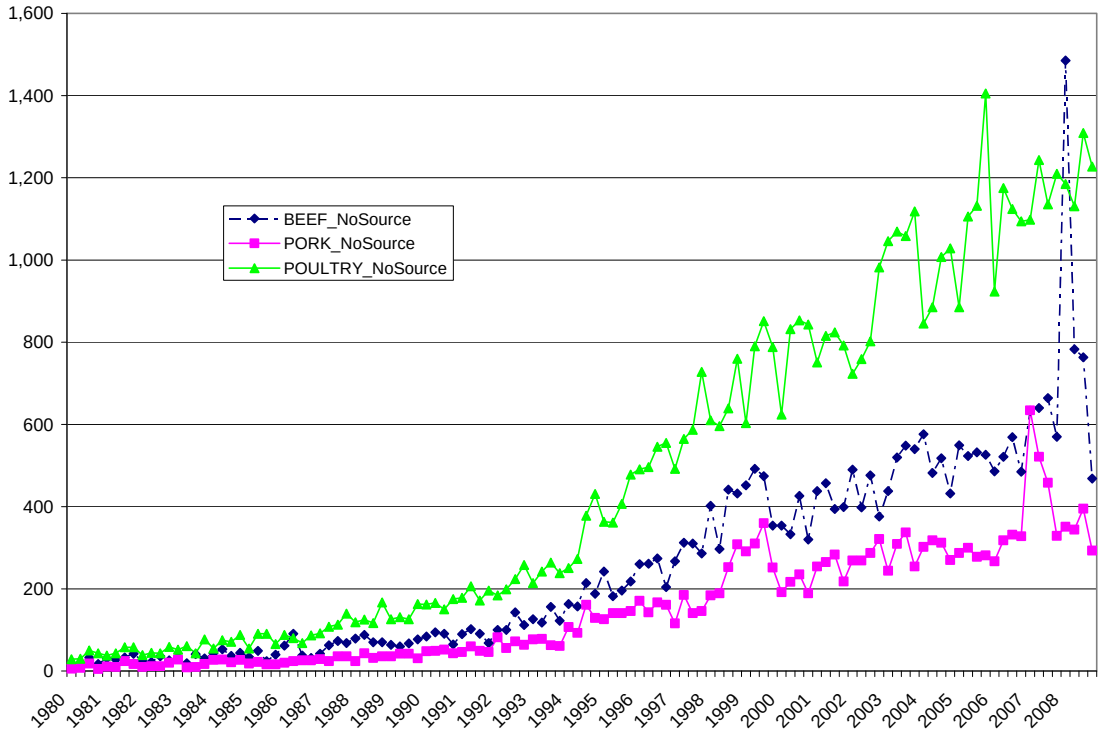
Table 7. Estimated Compensated Elasticities - Government Indices Model.

	Quantity of:			
with respect to:	Beef	Pork	Poultry	Other Food
Beef Price	-0.4812**,[a]	0.0721	0.0610	0.0058**
Pork Price	0.0399	-0.7606**,[a]	-0.1294	0.0060**
Poultry Price	0.0229	-0.0878**	-0.0666[a]	0.0007
Other Food Price	0.4185**	0.7763**	0.1351	-0.0125**,[a]
Expenditure	0.3363*,[b]	0.0872 [b]	0.1219 [b]	1.0209**,[b]
Short Run AW Elasticities:				
BEEF_Government	0.0107**			-0.0001**
PORK_Government		-0.0013		0.0000
POULTRY_Government			0.0184**	-0.0001**
Long Run AW Elasticities:				
BEEF_Government	0.0085*			-0.0001*
PORK_Government		0.0067		-0.0001
POULTRY_Government			0.0086	0.0000

Note: Log-likelihood value is 2,253.59; R-square statistics of the beef, pork, and poultry share equations are 73.1%, 84.2%, and 79.9%, respectively. Elasticities are calculated at the mean values of the explanatory variables. All *p*-values were obtained using Krinsky-Robb bootstrapping procedures. *Long-run AW* elasticities capture contemporaneous and one-quarter lagged effects.

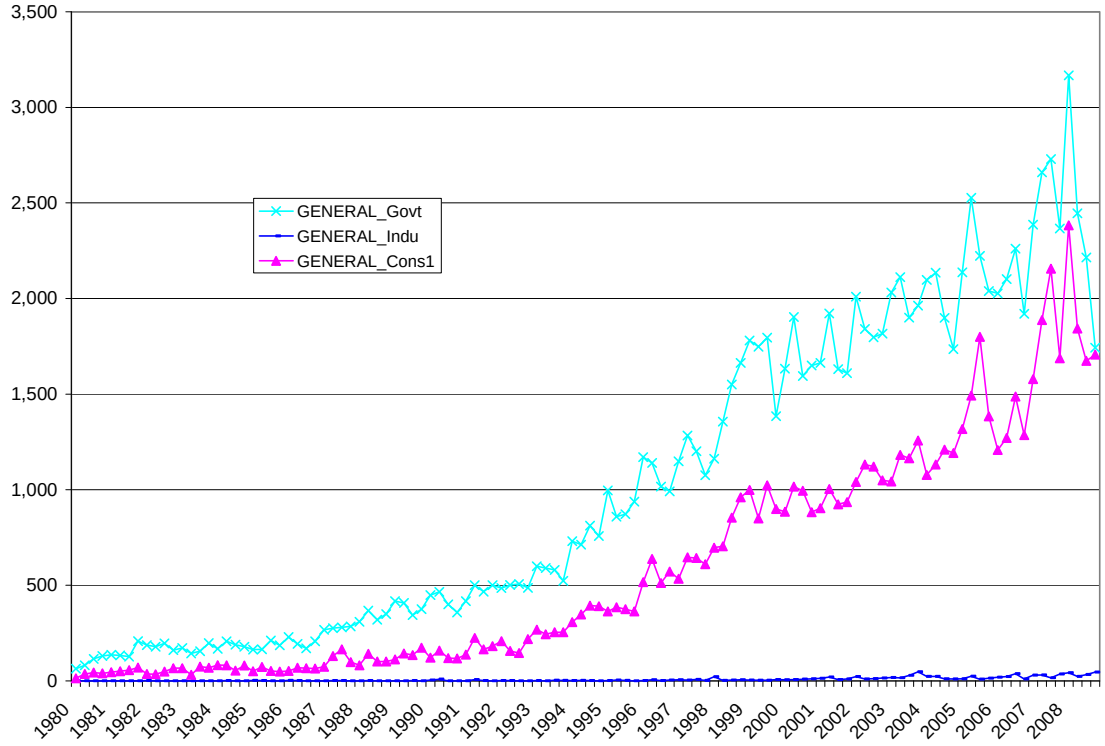
*, ** denote elasticities significantly different from 0 at the 15% and 10% level, respectively; [a] denotes own-price elasticities significantly greater than -1.0 at the 10% level; [b] denotes expenditure elasticities significantly different from 1.0 at the 10% level.

Figure 1. Species-Specific Indices



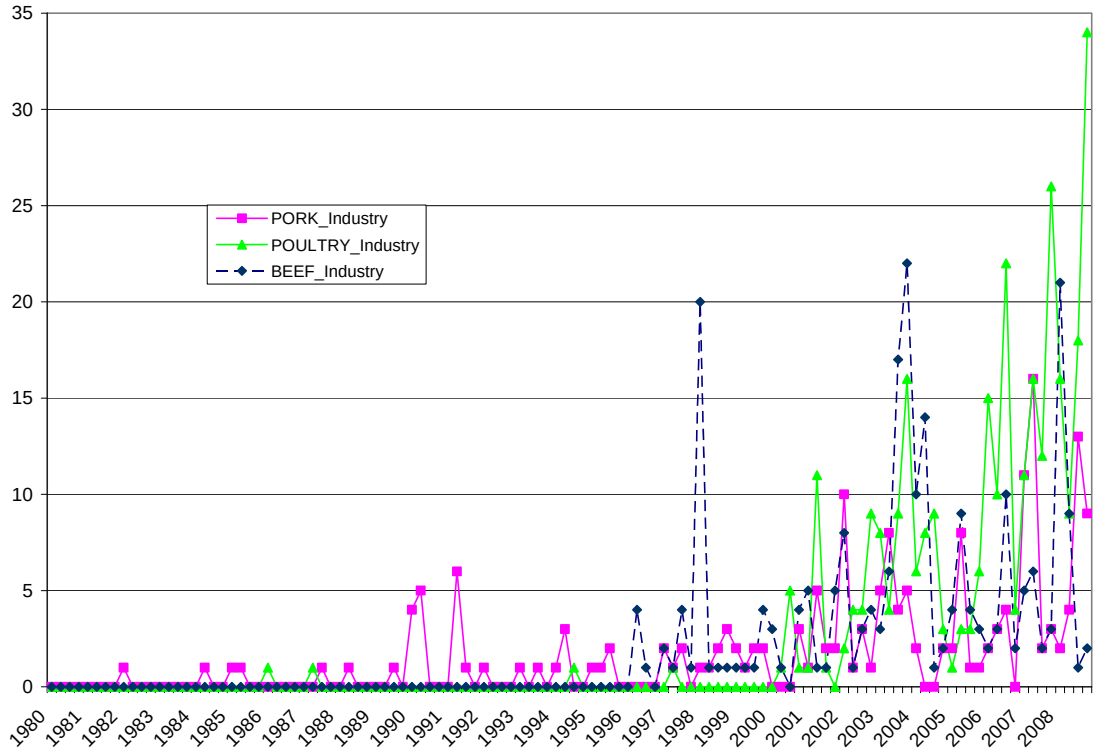
Note: Details on the creation of these indices are provided on pages 10-12.

Figure 2. Source/Entity Delineated General Indices



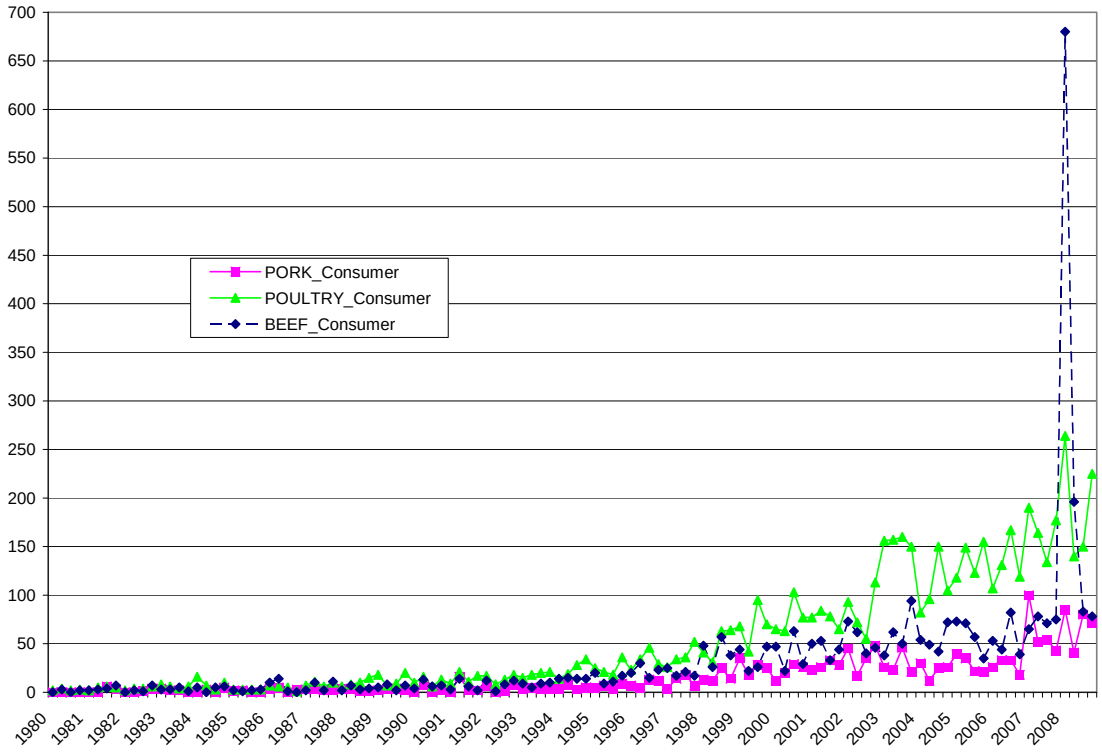
Note: Details on the creation of these indices are provided on pages 10-12.

Figure 3. Species-Specific, Industry Indices



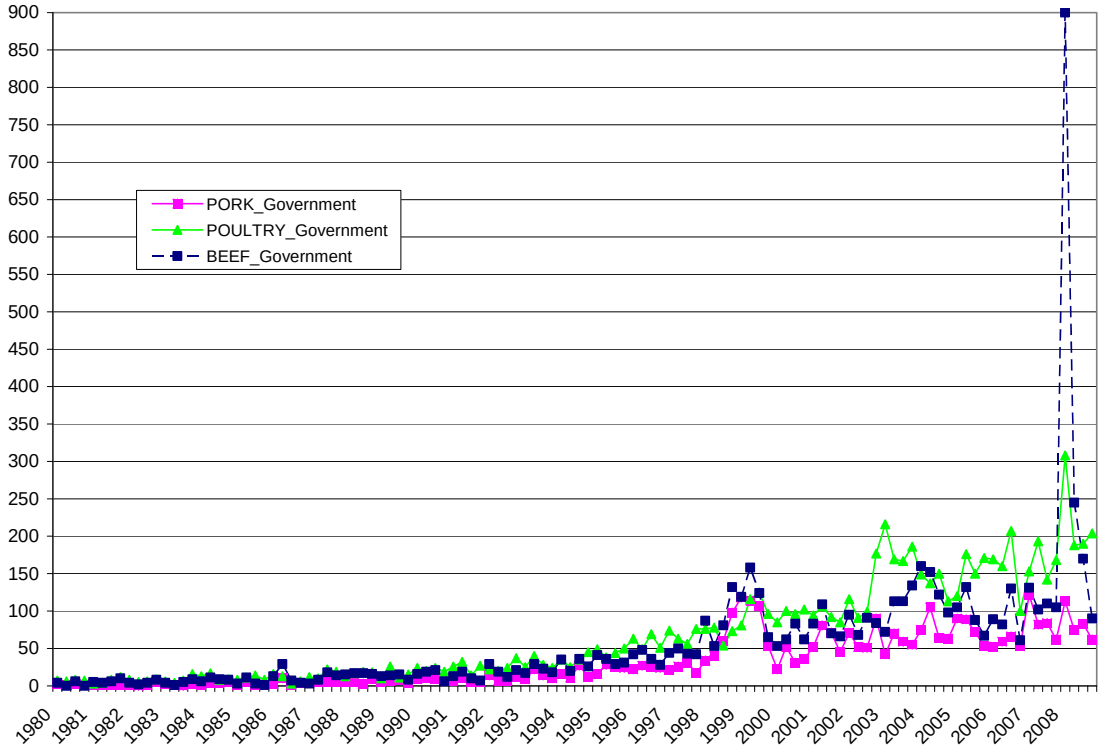
Note: Details on the creation of these indices are provided on pages 10-12.

Figure 4. Species-Specific, Consumer Group Indices



Note: Details on the creation of these indices are provided on pages 10-12.

Figure 5. Species-Specific, Government Indices



Note: Details on the creation of these indices are provided on pages 10-12.